GT5 Reference Event Selection Criteria

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Overview

- Objectives
- A brief history of event selection criteria for bulletin search
- GT5 selection criteria (development and validation)
- Summary and future work

Objectives

Reference events with location accuracy of 5 km or better are badly needed in location calibration and regional and teleseismic tomography

- Establish GT5 criteria for selecting candidate reference events from bulletins
- Validate GT5 selection criteria
- Caveat: origin time is as good (bad) as the velocity model

History, 20th century

- Sweeney (1996), teleseismic location accuracy of 10-15 km
  - **ndef $\geq$ 50 and gap $\leq$ 200°**
- Engdahl et al. (1998), EHB event selection from ISC bulletin
  - **gap $\leq$ 180°**
- Sweeney (1998), revised 15 km accuracy
  - **ndef $\geq$ 50 and gap $\leq$ 90°**
- Bondár (1998), GT categories introduced at the CMR
  - **GT10: nsta $\geq$ 5 within 2° and gap $\leq$ 180° within 5°**
  - **GT25: ndef $\geq$ 50 and gap $\leq$ 90°**
- Dewey et al. (1999), GT10 criteria, first attempt to validate criteria
  - **Stringent: nsta $\geq$ 10 and gap $\leq$ 90° within 250 km, at least one station within 30 km, mb $\geq$ 3.5**
  - **Relaxed: nsta $\geq$ 5 and gap $\leq$ 180° within 250 km, mb $\geq$ 3.5**
  - **Acceptance: relocated event within 5 km of regional network location and semi-major axis $\leq$ 5 km**

History, 21ˢᵗ century

- Dewey and Kork (2000), promotion to GT5
  - stringent criteria and relocated event within 2.5 km of regional network location and semi-major axis £2.5 km and not in source region with known bias
- Group2 Consortium (2000), GT5 criteria (after Dewey)
  - nsta ³ 10 and gap £120° within 250 km, at least one station within 30 km, recorded beyond 250 km
  - Acceptance: cluster analysis (Engdahl and Bergman, 1999, 2000, 2001)
  - GT5 promotion from cluster analysis: semi-major axis £5.5 km
- Myers and Schultz (2001), Dead Sea explosion study
  - showed that Group2 GT5 criteria are not stringent enough
- Bondár et al. (2001), revised GT5 criteria, validation w.r.t. GT0
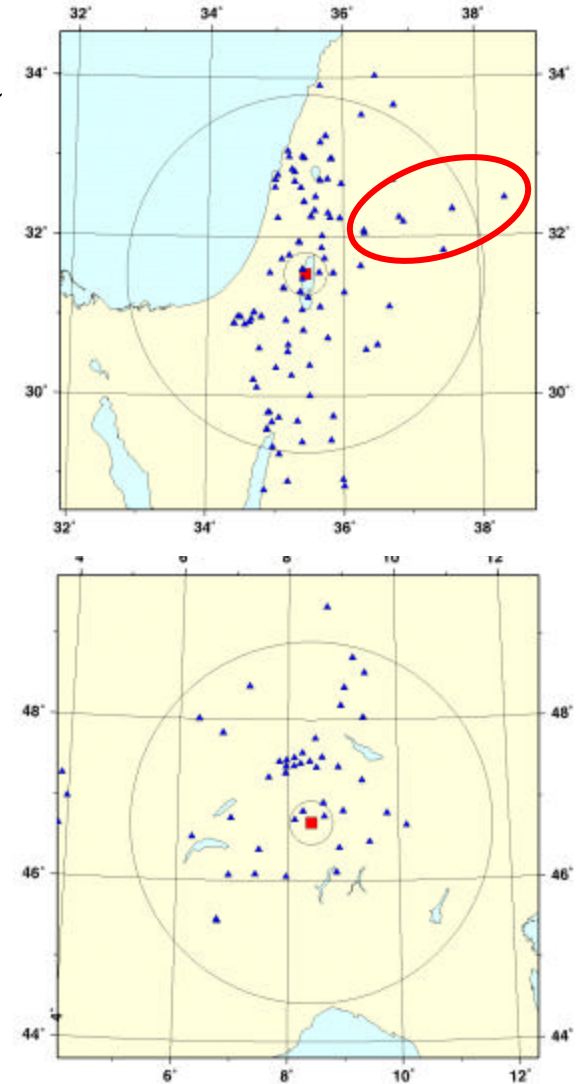 - GT5 at the 90% and 95% confidence levels

Search for GT5 selection criteria

Relocation of two GT0 events (Dead Sea explosion, Swiss ammunition storage explosion)

- 10 randomly chosen stations within 250 km, free depth solution, 10,000 realizations each
- Measure gap, sgap, nsta within 30 km, nsta in each quadrant

Introduced secondary azimuthal gap
- The largest azimuthal gap filled by a single station
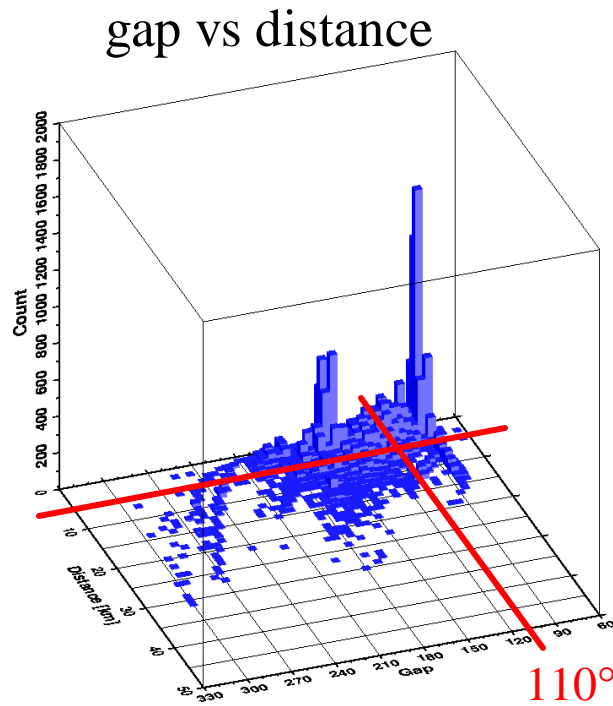- Reduces relative station importances, location less vulnerable to picking errors
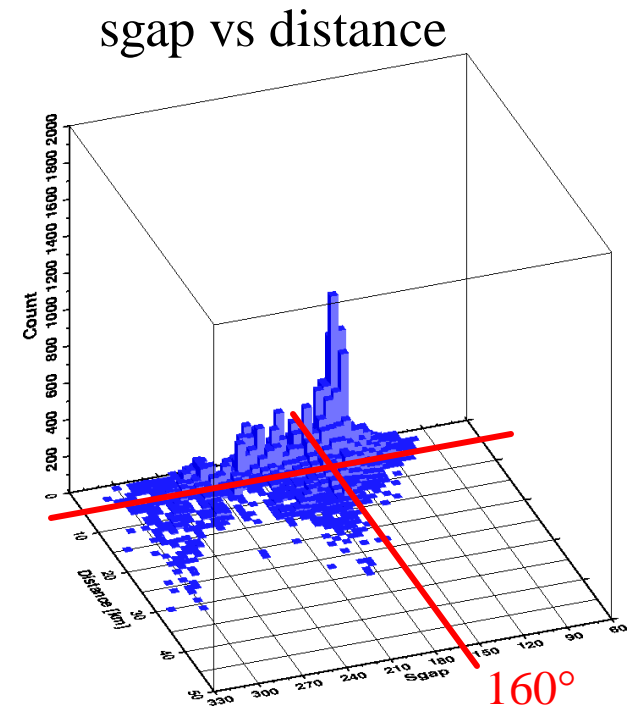
Search for GT5 selection criteria

- There is no silver bullet to select GT5 events
- Criteria that minimize the number of outliers and maximize the number of events with 5 km location accuracy at the 90% and 95% confidence level
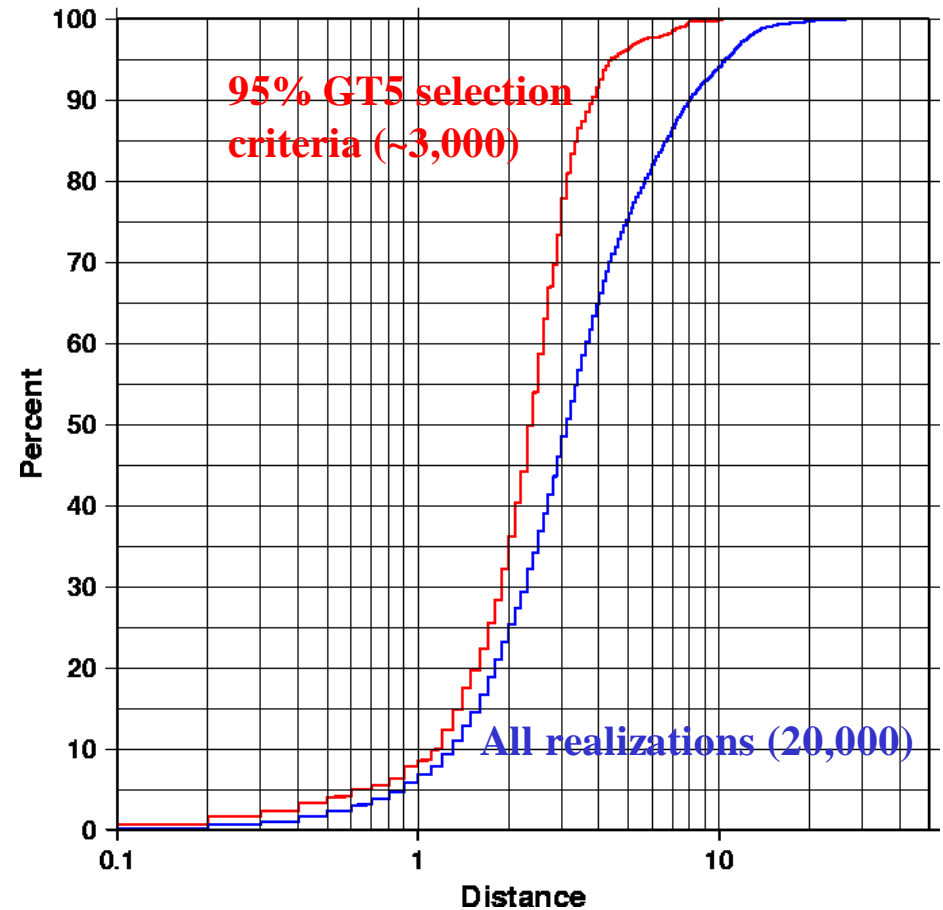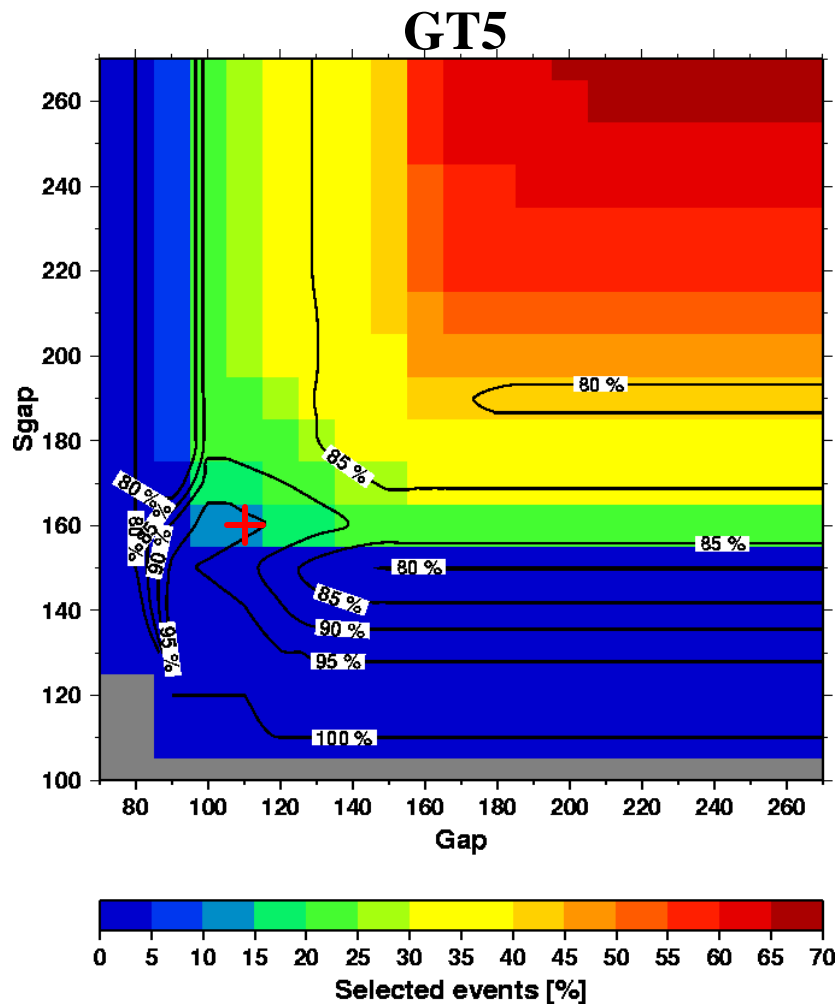
mislocation

gap vs distance

sgap vs distance
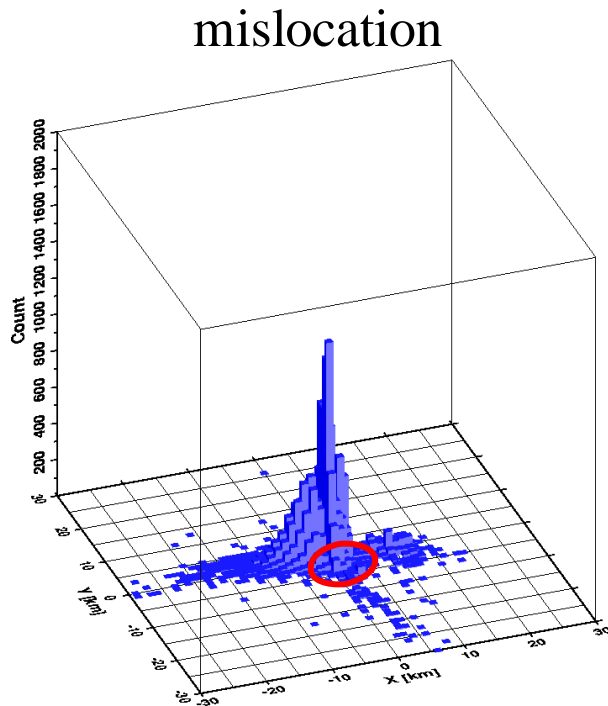
Search for GT5 selection criteria

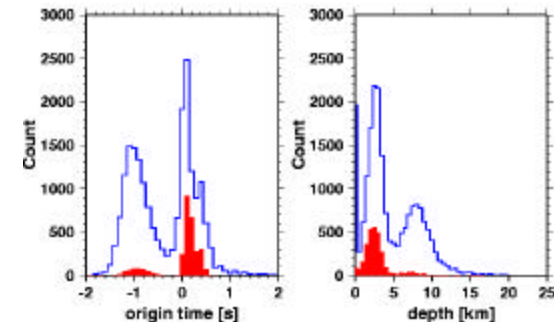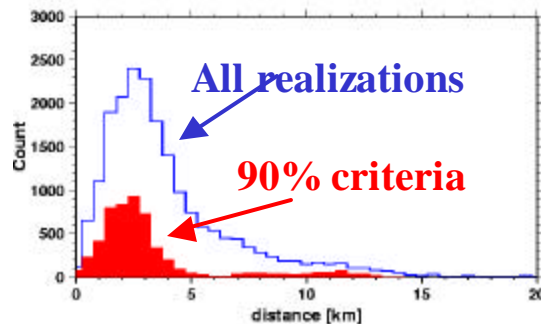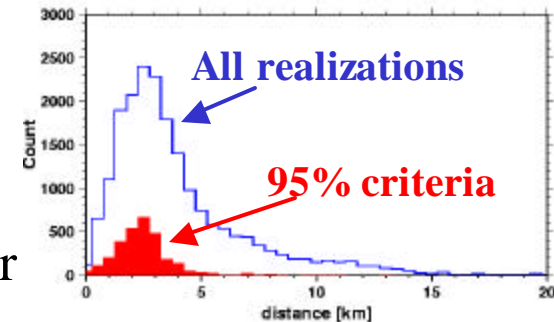Color scale: % of events with gap and sgap, contours: % of events within GT5

GT5 selection criteria

At the 95% confidence level

– At least 10 stations within 250 km with azimuthal gap ≤ 110° and secondary azimuthal gap ≤ 160°
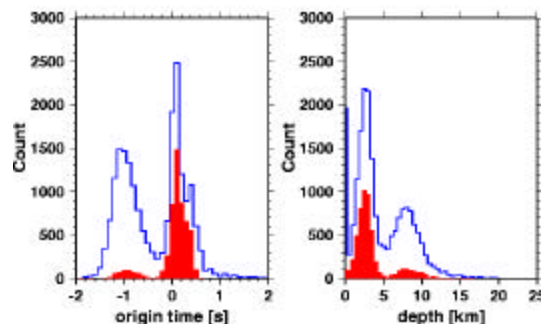– At least one station within 30 km from the epicenter
– Event is recorded beyond 250 km

Selects GT10 at the 99.5% confidence level

At the 90% confidence level

–At least 10 stations within 250 km with azimuthal gap ≤ 110°
–At least one station within 30 km from the epicenter
–Event is recorded beyond 250 km

Selects GT10 at the 93% confidence level

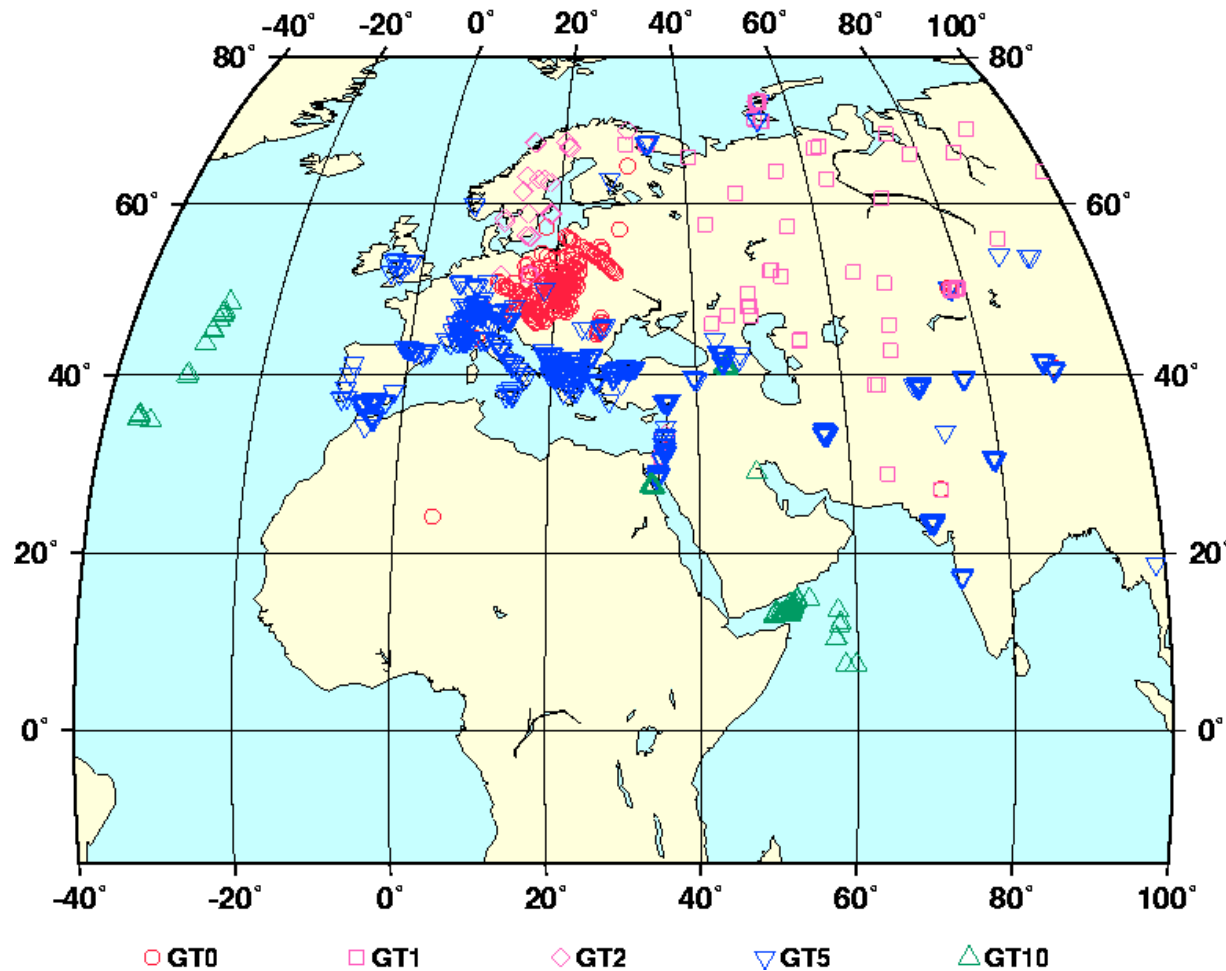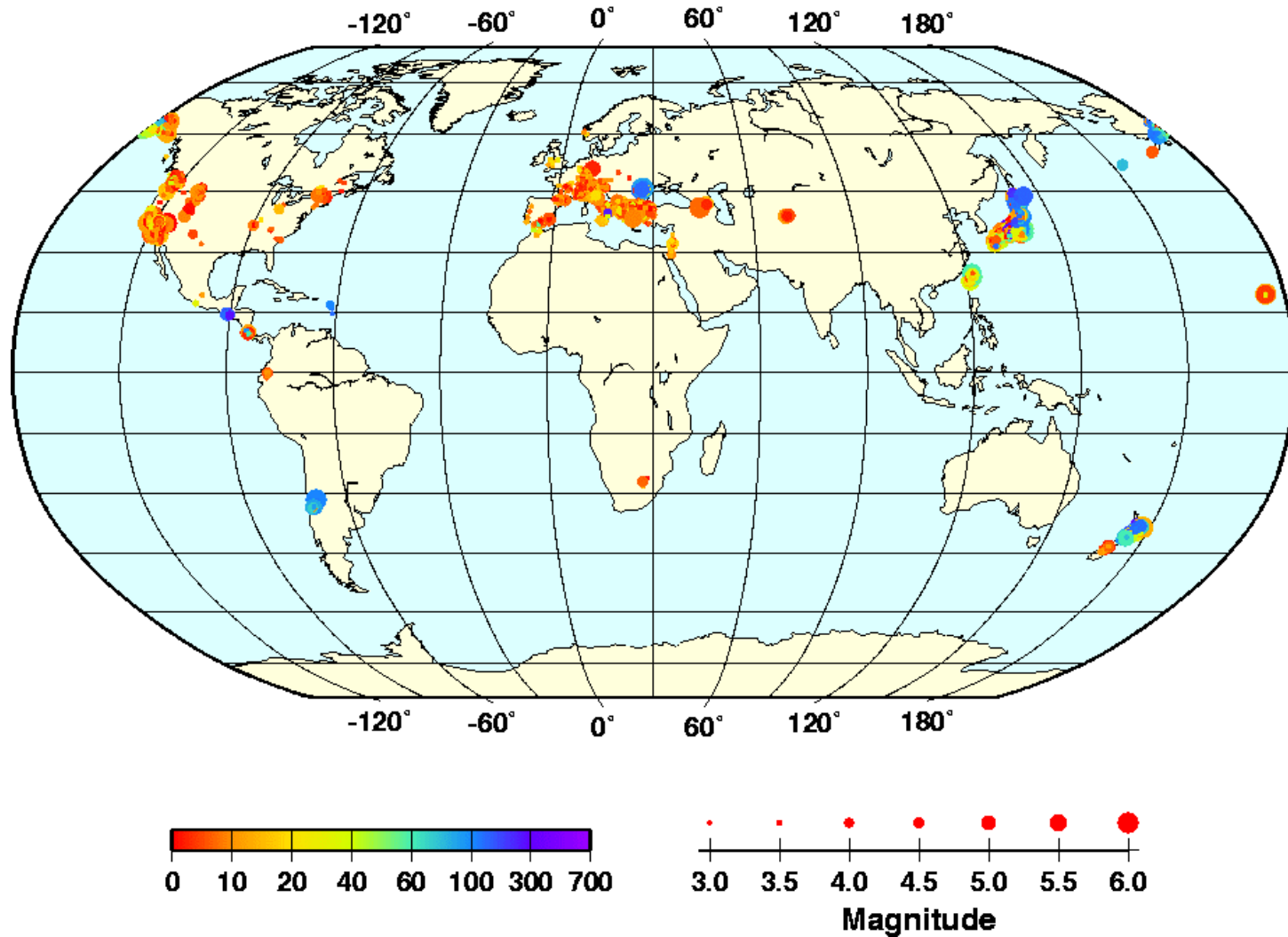# Validation of GT5 candidate events

- Each reference event should be documented with metadata
- Cluster analysis
  - candidate events are validated if multiple event location results are consistent with reference event information
  - Events from a cluster are promoted to GT5 if the semi-major axis of their error ellipse is less than 5.5 km
  - HDC and JHD techniques were cross-validated to ensure they give similar results
- Relocation using stations within 300 km if clusters cannot be formed
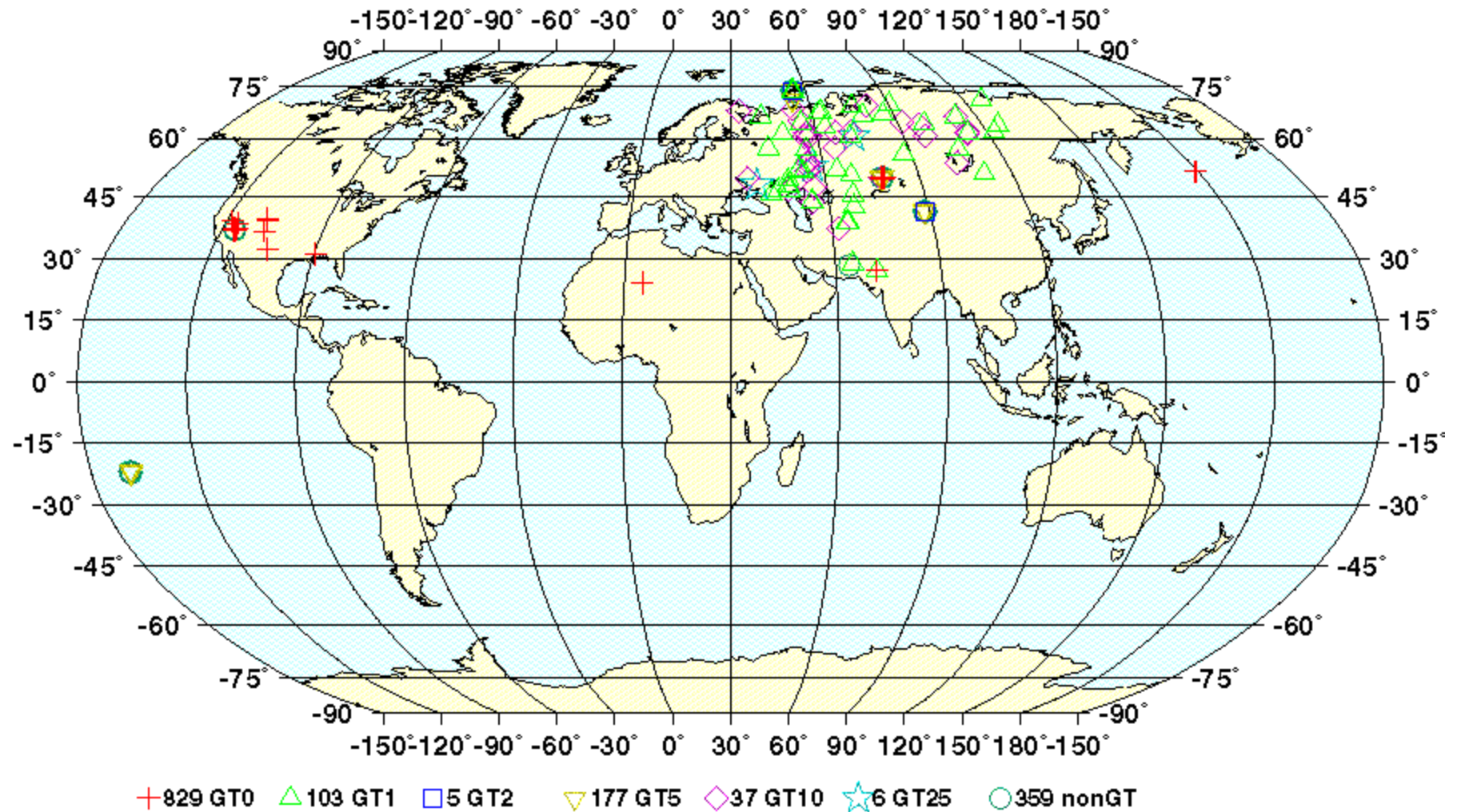
Group2 Reference Event List 2.0

1,861 validated GT0-10 reference events (http://g2calibration.cmr.gov)

20,321 EHB GT5 candidates

1,114 GT5 or better UNEs in CMR DB

+829 GT0   △103 GT1   □5 GT2   ▽177 GT5   ◇37 GT10   ☆6 GT25   ○359 nonGT

Summary

- GT5 candidate reference event selection criteria at the 90% and 95% confidence levels are established and validated

- Some 20,000 events in the EHB satisfy the GT5 criteria at the 95% confidence level

- Some 1,800 validated and documented reference events in the Group2 region

- Future work:
  - address depth and origin time
  - devise GT10-GT15 selection criteria for regional and teleseismic networks